length of its propodus is 13¼ inches; the girth just proximal to dactyl is 16½ inches. The propodus of cutting claw is somewhat smaller; length 12¾ inches, girth 12¼ inches.

The pleon is 11 inches in length, and the girth of tergum of second segment—spine to spine—is 8⅝ inches.

Apparently this specimen is larger than the one described by Herrick, if we consider only the length. This is due to the perfect rostral spine, which was broken in the Boothbay specimen. If we take the length from base of rostrum to tip of telson—a fair measurement to give an idea of bulk—we find the Block Island specimen is 19 inches, while the one from Boothbay is 19¼ inches.

By taking the average of the differences in measurements of the two specimens, I find that the one described by Herrick is larger by about six per cent.

While therefore this specimen is not the largest on record, its perfect condition warrants its description, as it so nearly approaches the maximum in size of the American lobster so far authentically reported.

F. C. WAITE.
HARVARD UNIVERSITY, August 1, 1896.

SCIENTIFIC LITERATURE.

Mars. By PERCIVAL LOWELL. Boston: Houghton, Mifflin & Co. 1895. 8°. Pp. 228+viii; xxiv illustrations.

I am pleased to comply with the Editor's request for a review of Mr. Lowell's interesting book.

The reviewer of a work on organic evolution would find it difficult to avoid mentioning Darwin. Schiaparelli holds a similar place in the literature of Mars. An intelligent criticism of any recent book on Mars must consist largely of a review of Schiaparelli's observations and ideas. Of his predecessors it will be well to mention, for the benefit of non-astronomical readers, the following: (*a*) Galileo (1610), who discovered the phases of the planet, thereby proving that its light, though very red, is really reflected sunlight; (*b*) Huyghens (1659), who first observed marking on the surface; (*c*) Cassini (1666), who determined the length of the Martian day, and discovered the white polar caps; (*d*) Sir William Herschel (1783), who observed the waxing and waning of the polar caps with the seasons; (*e*) Beer and Maedler, who published the first map on the planet's surface features, and discovered at least three of the so-called canals; (*f*) Dawes (1864), whose drawings show a dozen of the canals; and (*g*) Hall (1877), who discovered the two satellites.

Schiaparelli's work extends continuously from 1877 on. It is impossible to do justice to his labors in this article. He extended our knowledge of the planet enormously in nearly every line—in reference to the polar caps, the so-called seas and continents, but especially in reference to the so-called canals, their appearance and disappearance, their doubling, etc. His entire work bears the impress of a scientific spirit *par excellence*. His observations cover the period 1877–92, but his technical results are comprised in a few papers, and a dozen 8vo. pages suffice for a masterly popular exposition of his general results. His brief papers contain at least the suggestion of all the theories recently exploited by popular writers, though he was not concerned with establishing a theory, but rather with ascertaining facts.

Schiaparelli's remarkable observations of the network of straight canals and their doubling were questioned for years, but the confirmation they finally received at Nice and elsewhere largely removed the doubt.

Mr. Lowell's book on Mars is based upon the Flagstaff, Arizona, observations made by himself between May 31 and November 20, 1894, and by Prof. W. H. Pickering and Mr. A. E. Douglass between May, 1894, and April, 1895. Mr. Lowell delivered a lecture under the auspices of the Boston Scientific Society, on May 22, 1894, in which he is reported (*Boston Commonwealth* for May 24, 1894,) to have announced that his observatory—not yet completed—was for the purpose of making "an investigation into the conditions of life in other worlds, including last, but not least their habitability by beings like or unlike man. This is not the chimerical search some may suppose. On the contrary, there is strong reason to believe that we are on the eve of pretty definite discovery in the matter."

Speaking of Schiaparelli's canals on Mars, Mr. Lowell is reported to have said in his lec-

ture, "the most self-evident explanation from the markings [canals] themselves is probably the true one; namely, that in them we are looking upon the result of the work of some sort of intelligent beings. * * * The amazing blue network on Mars hints that one planet besides our own is actually inhabited now. * * * We stand upon the threshold of a knowledge of our closest of kin in the world of space, of the the most important character."

Mr. Lowell went direct from the lecture hall to his observatory in Arizona, and how well his observations established his pre-observational views is told in his book. In outline his conclusion is that there is a scarcity of water on Mars; that the melting of the polar snows is the source of water supply for the planet; that a network of straight canals conducts the water from the poles over the planet; that what we see and call canals are not water, but vegetation along the banks—a suggestion made several years ago by Schiapparelli and by Prof. Pickering; that since the canals are all straight, *i. e.*, run on great circles, and are of uniform width, and in general several of them intersect in one point, then they probably are the handiwork of the Martian inhabitants; that the planet is probably inhabited by highly intelligent beings; and that the irrigation problem is their chief concern.

It will be seen that Mr. Lowell's results agree perfectly with his pre-observational views quoted above; but in justice to him it must be said that he has written vigorously and at length (pp. 158–161) of the dangers of bias on the part of those having preconceived notions, and in numerous paragraphs throughout the book severely criticises those who write on the subject without having made the observations. So I suppose we shall have to forget his remarkable preliminary lecture.

Before examining Mr. Lowell's evidences of intelligent beings on Mars, let us look at his idea of how the world would receive such a discovery. He believes the world would not welcome it. "To be shy of anything resembling himself is part and parcel of man's own individuality. * * * The civilized thinker instinctively turns from the thought of mind other than the one he knows." Various astounding hypotheses "commend themselves to man, if only by such means he may escape the admission of anything approaching his kind. * * * It is simply an instinct like any other, the projection of the instinct of self-preservation."

Here Mr. Lowell is certainly wrong. In my opinion, he has taken the popular side of the most popular scientific question afloat. The world at large is anxious for the discovery of intelligent life on Mars, and every advocate gets an instant and large audience. Scientific men are quite ready to admit the possibility of life wherever the environment is shown to be suitable. While we can safely say that other suns than ours have their planets and some of those planets probably support life, yet only two cases have come under satisfactory observations: the Earth and the Moon. The former is inhabited; we may safely say the latter is not. In size certainly, and in physical condition probably, Mars is somewhat nearer the Moon that the Earth; and while the affirmative side of the question, 'Is Mars inhabited?' will get at least a just hearing, those who advocate that side must prepare the burden of proof.

Speaking of the melting of the northern polar cap of Mars, Schiaparelli wrote in 1892: "From this arises a singular phenomenon which has no analogy upon the Earth. At the melting of the snows, accumulated at that pole during the long night of ten months or more, the liquid mass produced in that operation is diffused around the circumference of the snowy region, converting a large zone of surrounding land into a temporary sea and filling all the lower regions. This produces a gigantic inundation. * * * The white spot of snow is surrounded by a dark zone, which follows its perimeter in its progressive diminution, upon a circumference ever more and more narrow. The outer part of this zone branches out into dark lines, which occupy all the surrounding region, and seem to be distributary canals by which the liquid mass may return to its natural position. This produces in these regions very extensive lakes. * * * This inundation is spread out to a great distance by means of a network of canals, perhaps constituting the principal mechanism (if not the only one) by which water

(and with it organic life) may be diffused over the arid surface of the planet; because on Mars it rains very rarely, and perhaps even it does not rain at all. * * * Such a state of things does not cease until the snow, reduced to a minimum area, ceases to melt. Then the breadth of the canals diminishes, the temporary sea disappears, and the yellow region again returns to its former condition. The different phases of these vast phenomena are renewed at each return of the seasons, and we have been able to observe them in all their particulars very easily during the oppositions of 1882, 1884 and 1886, when the planet presented its northern pole to terrestrial spectators. The most natural and most simple interpretation is that to which we have referred, of a great inundation produced by the melting of the snows. * * * We conclude, therefore, that the canals are such in fact, and not only in name. * * * that the lines called canals are truly great furrows or depressions in the surface of the planet, destined for the passage of the liquid mass and constituting for it a true hydrographic system."*

At the 1894 opposition the axis of Mars was tilted so that the region between the south pole and 40° north latitude was presented to terrestrial observers, the north polar region being hidden from sight. Mr. Lowell's observations covered one-fourth of the Martian year, from May 1st to August 1st, Martian time. His book pays special attention to the melting of the south polar cap, and to what he considers to be the train of related phenomena; since around and upon those phenomena he builds his argument for intelligent life on that planet. On May 1st, Martian time, the south cap was "in rapid process of melting. * * * As it melted, a dark band appeared surrounding it on all sides. Except, as I have since learned, at Arequipa, this band has never, I believe, been distinctively noted or commented on before, which is singular, considering how conspicuous it was at Flagstaff." (This last sentence is indeed surprising, as scores of drawings published in 1892 and earlier show this dark band very conspicuously; it is well known to all observers of Mars, and Schiaparelli's description of the same phenomena at the melting of the north polar cap is very familiar.) "As the snows dwindled, the blue band shrunk in width to correspond," and finally, when the cap had entirely disappeared, its encircling dark band had also vanished. Mr. Lowell believes the dark band was water, and that it disappeared by flowing away from the pole towards the equator in canals, circulating through the planet's arid regions. In proof thereof he submits that he has observed a slow wave of dark area to advance equator-ward from the poles; that the canals nearest the south pole grew dark and thereby became visible first; then those nearer the equator; then those at the equator; and finally those north of the equator; in other words, in the order that water flowing from the south pole would reach different parts of the planet.

It will be seen that the Flagstaff observations upon the melting of the south polar cap and the flow of water therefrom are identical with those made (and published) by Schiaparelli in the case of the north polar cap in 1882, 1884 and 1886; but these observations by Schiaparelli are not mentioned in Mr. Lowell's book. The Flagstaff observations in a measure confirm Schiaparelli's general results and extend them to the region of the south pole.

Of the origin of the canal system Schiaparelli writes entertainingly: "Their singular aspect, and their being drawn with absolute geometrical precision, as if they were the work of rule or compass, has led some to see in them the work of intelligent beings, inhabitants of the planet. I am very careful not to combat this theory, which includes nothing impossible. * * * The network formed by these was probably determined in its origin in the geological state of the planet, and has come to be slowly elaborated in the course of centuries. It is not necessary to suppose them the work of intelligent beings; and notwithstanding the almost geometrical appearance of all of their system, we are now inclined to believe them to be produced by the evolution of the planet, just as on the Earth we have the English Channel and the Channel of Mozambique."

Of the gemination of the canals Schiaparelli

* For this and other passages from Schiaparelli's Italian papers I am indebted to Professor Pickering's translation in *Astronomy and Astro-Physics*, 1894.

writes: "In consequence of a rapid process, which certainly lasts at most a few days, or even perhaps only a few hours, * * * a given canal changes its appearance, and is found transformed through all its length into two lines or uniform stripes, more or less parallel to one another, and which run straight and equal with the exact geometrical precision of the rails of a railroad. * * * One of these is often superposed as exactly as possible upon the former line, the other being drawn anew. * * * But it also happens that both the lines may occupy opposite sides of the former canal and be located upon entirely new ground. The distance between the two lines differs in different geminations, and varies from 360 miles and more, down to the smallest limit at which two lines may appear separated in large visual telescopes—less than an interval of 30 miles." Schiaparelli explains that the variations might be the result of "extensive agricultural labor and irrigation upon a large scale. Let us add further that the intervention of intelligent beings might explain the geometrical appearance of the gemination, but it is not at all necessary for such a purpose. The geometry of nature is manifested in many other facts, from which are excluded the idea of any artificial labor whatever. * * * It would be far more easy if we were willing to introduce the forces pertaining to organic nature. Here the field of plausible supposition is immense, being capable of making an infinite number of combinations, capable of satisfying the appearances even with the smallest and simplest means. Changes of vegetation over a vast area * * * may well be rendered visible at such a distance. * * * For us, who know so little of the physical state of Mars and nothing of its organic life, the great liberty of possible supposition renders arbitrary all explanations of this sort, and constitutes the gravest obstacle to the acquisition of well founded notions."

Such, in effect, is all that Schiaparelli has written by way of explanation of his remarkable discoveries, and he who runs may read his scientific mind.

Mr. Lowell's book contains a beautiful map of the portion of Mars lying between 70° south and 40° north latitude (on Mercator's projection). It represents the *ensemble* of the individual sketches made by Messrs. Lowell, Pickering and Douglass at Flagstaff in November, 1894. It contains 183 canals, lying both in the light and dark regions of the planet. Of those lying in the light reddish regions, 63 appear to be identical with those discovered by Schiaparelli and his predecessors, and 72 appear to be new. Mr. Douglass is credited with the discovery of 44 canals in the dark regions of the planet. I infer from Mr. Lowell's book that the canals in the dark regions were not seen and confirmed by either Mr. Lowell or Prof. Pickering, though they were observing Mars at the same time and place. Evidently, then, these observations at Flagstaff were difficult, and Mr. Lowell considers them to be new, though they are not new. In 1892 Prof. Schaeberle observed them, and wrote that "Crossing the darker areas are still darker streaks which often extend hundreds of miles in nearly straight lines. One end of a given streak usually terminates in the equatorial region at a point where the dark area protrudes into the bright area, and the so-called canals seem to be continuations of the streaks" (*Publications* Ast. Soc. Pacific., iv., 197). It was often noticed in 1894 by the writer and other Lick observers that the dark areas on Mars were composed of a mass of details so complex as to defy the draughtsman's skill; but I think Mr. Douglass, at Flagstaff, is the only observer who has verified Prof. Schaeberle's 1892 observations that these markings were arranged in nearly straight lines. If the observations by Messrs. Schaeberle and Douglass are to extend the canal system over the dark areas, just as Schiaparelli's extend them over the bright areas, they constitute a most important advance in Martian work. The recent observations of canals or other details within the dark areas, the recent spectroscopic and polariscopic observations, all strongly oppose the favorite theory that the dark areas are seas, but support the common theory that the bright areas are land.

Mr. Lowell observed a few double canals, probably a fourth as many as Schiaparelli saw.

At the exact point where two or more canals cross each other the observers noticed that

there was in nearly every case a dark circular or oval spot acting as the hub from which the canals radiated as spokes. To these swollen junctions Mr. Lowell applies the name 'oases.' A few of these spots were observed by Schiaparelli and others, but the Flagstaff observers have greatly extended the list.

As explained above, Mr. Lowell accepts the suggestion made by Schiaparelli and others that the canals form the planet's hydrographic system; that the changes observed may be due to vegetation, to irrigation on a large scale. He holds that the *visible* canals and the 'oases' are due to vegetation along the lines of the *real* canals; and that the whole system essentially proves, or at least renders it very probable, that Mars is inhabited by a highly intelligent race whose chief concern is irrigation. His argument is made with great skill. Every fact is considered to point in that direction, and every observed phenomenon is considered to be accounted for, though in explaining the mysterious doubling of the canals he admits that "we are here very much in the dark." It is held that the canals being vegetal in character, and watered from the melting snow at the poles, are seasonal, developing in the order of their distance (in time) from the poles, and reach their highest development at or shortly after the time of summer solstice. Such, in fact, is the train of phenomena which Mr. Lowell claims to have observed, starting from the south pole and extending to about 40° north latitude. Schiaparelli observed similar phenomena in the vicinity of the north pole, when that region was in position for observation. His sketches made at or shortly after the northern summer solstice cover the region from the north pole to about 40° south latitude.

Let us examine Mr. Lowell's irrigation scheme. A hydraulic engineer would ask some questions which Mr. Lowell does not discuss in his book. In the southern summer Mr. Lowell has the planet's surface covered with canals running in every direction, from the south pole to at least 43° north latitude; as far as the tilted position of Mars permitted him to see. We do not know but that they extended entirely to the north pole. In the northern summer Schiaparelli's system of canals extended from the north pole southward to 30° south latitude, or further; in fact, as far as the position of the planet permitted him to see. And it is agreed by Mr. Lowell that his principal canals are identical with Schiaparelli's. So we are asked to believe that the equatorial region of Mars, forming a strip at least 70° wide, can be and is irrigated from both the north and south poles; the 'canals' in the two cases of opposite flow being identical! The corresponding problem on the Earth would be to irrigate San Francisco, Chicago, New York, Rome, Tokyo, from the snow melting at the South Pole; and to irrigate Valparaiso, Cape of Good Hope, Australia, from the snow melting at our North Pole: all the irrigated land lying between New York, etc., on the north and the Cape of Good Hope, etc., on the south to be irrigated alike from the North and South Poles. Mr. Lowell ventures no explanation of how this engineering problem is to be worked out, though he states that the canals form a system "precisely counterparting what a system of irrigation would look like; and, lastly, that there is a set of spots placed where we should expect to find the land thus artificially fertilized, and behaving as such constructed 'oases' should."

If the visible canals are due to irrigated vegetation in strips 30 to 60 and more miles wide, traversing the planet's surface in straight lines in every direction, all the canals hundreds and many of them thousands of miles long, from four to ten canals radiating from a common point, intersecting at all angles a great many other canals radiating from other centers, how is the water distributed over this large and complex area? It starts from the polar snows, we are told, and flows thousands of miles to and beyond the torrid zone, spreading in a general way over the whole planet. Do these streams lie in the valleys, or on the slopes and ridges? There is no evidence whatever that the surface is remarkably level. The canals, apparently, do not turn aside for anything. The path of least resistance seems to be unknown.

The crater *Tycho*, on our moon, is the center of a system of markings radiating in all directions in straight lines, hundreds and thousands of miles. They cross hills and valleys with per-

fect indifference. Because they are straight and radiate from a center, did they have an intelligent personal origin?

Is a seasonal change on Mars evidence of an intelligent population? The virgin forests and prairies of America donned and doffed their annual green suit even better before the advent of man than to-day.

The organic origin of the dark areas on Mars has great advantages, as Schiaparelli said; but the addition of intelligent beings to the hypothesis adds to, rather than removes, the difficulties, and leads to pure speculation. If we attempt an explanation of the irrigation system we can, in our dilemma, only say that the Martians are more intelligent than we are!

The most striking feature of the Flagstaff observations relates to the detection of a large number of canals and 'oases.' It is a question how far these observations have had confirmation, and how far they need it. The observation of 44 canals in the dark areas by Mr. Douglass confirms Prof. Schaeberle's 1892 observations, but they were evidently not seen by Messrs. Lowell and Pickering. Mr. Lowell gives a long list of canals in the bright areas, but it is uncertain whether or not they were seen by more than one observer. His list contains nine canals that were seen on only one occasion; they are drawn on the final map and given names. His list contains one canal that *was not seen at all*, but on *one* occasion was *suspected*; it is put on the map and given a name.

Mr. Lowell accepts the line of reasoning put forth by Proctor and others as to the extent of Mars' atmosphere, viz.: That the mass of terrestrial atmosphere is to the mass of Mars' atmosphere as the mass of the Earth is to the mass of Mars; which leads to the result that the density of the atmosphere at the surface of Mars is about half the density of our atmosphere at the summit of the Himalayas. This is in complete harmony with the Lick spectroscopic results of 1894, which pointed to that density as the maximum limit, but is quite out of harmony with the earlier spectroscopic results.

It is well known that the atmosphere of Mars is practically cloudless. There is some evidence of clouds near the terminator (sunrise and sunset line), and some in favor of occasional small clouds over the portions fully exposed to the sun's light and heat. For two or three weeks in October, 1894, all the surface features were partially obscured and rendered indistinct, as if by general haziness, after which they again became distinct. Mr. Lowell believes that the Flagstaff observers saw several hundred clouds near the terminator, though he makes no use of them in explaining Mars' hydrographic system. They are not needed for irrigation purposes. The atmosphere is supposed to be very rarefied, the polar snows melt, the water in some manner evaporates into the atmosphere to form the polar caps by precipitation the following winter. If snow is precipitated at the cold poles, why should not rain be precipitated in the warmer regions? If the atmosphere is thin and takes up the evaporated water in a clear noon sky, why should not the rarefied atmosphere cool rapidly at night and rain be precipitated, especially in the valleys? If the atmospheric circulation is slow, as it is supposed to be, the visible effects of night rains could well progress from the poles toward the equator, through the valleys, and a delicate system of surface levels would not have to be provided. This is not put forth as a theory of the canal system, except to emphasize the fact that we should give Nature a chance to do this work before we resort to artificial irrigation.

In 1890 there began at Mount Hamilton a new class of observations on Mars, relating to the bright projections on the terminator. Similar observations were made in 1892 and 1894. There is no doubt that they are very important, and great stress was laid on them. There are some arguments in favor of there being clouds, but many more in favor of there being mountains. The observed phenomena are fully explained by supposing a mountain chain to lie across the terminator and to disappear from sight by the planet's diurnal rotation. The observed projections were such as would be produced by the sun shining on the mountain tops outside the terminator, and the observed adjacent depressions were such as would be formed by the shadow of the mountain range lying within the terminator. Concerning the

1894 Flagstaff observations of the terminator by Mr. Douglass, Mr. Lowell writes that "Of the 736 irregularities observed, 694 were not only recorded, but measured. Of these, 403 were depressions. It is singular, in view of their easy visibility, that, with the exception of Schroeter, in the last century, no one should have noticed them before."

Mr. Lowell rejects 346 out of 403 depressions as not real, since they lay on the dark areas of the planet and were due to the smaller irradiation at those places. He holds that the remaining 57 depressions were due to clouds within the terminator, and 291 projections were clouds outside the terminator; because if they were mountains the number of depressions should equal the number of projections. To my mind, the argument is not convincing. If we remove 196 of the projections which are described as 'long and low,' and which some experience in observing them leads me to ascribe to excessive irradiation, we shall have 95 projections and 57 depressions of the 'short and sharp variety.' When we consider that these clouds or mountains (or something else) are immersed in an illuminated atmosphere, we cannot expect the projections and depressions to be equal in number. The problem will not be settled until it is determined whether or not the projections occupy fixed and the same positions at many successive oppositions—the phase and atmospheric conditions being equal.

I confess my inability to unravel Mr. Lowell's discussions of Mr. Douglass' observations. When it was a question of detecting a twilight effect it was the illuminated atmosphere which formed the visible and measurable terminator. When it was a question of proving that Mars was extremely level, and would, therefore, lend itself to general irrigation, it was the land surface that formed the visible terminator; and since this terminator was always "comparatively smooth, * * * we know that, relatively to his size, he has no elevations or depressions on his surface comparable to the lunar peaks and craters." Lastly, the several hundred irregularities observed on the terminator, varying from those extremely high to those very low, were attributed to clouds. The terminator, then, is formed by the illuminated atmosphere and not by the land surface; secondly, there are no significant elevations and depressions on the surface, because the terminator, formed by the land surface, is comparatively smooth; and thirdly, the extensive irregularities on the terminator, which 'may be seen every night,' are due to clouds.

Mr. Lowell writes of the 'long and low' irregularities that the projections averaged 0″.136 in height; the depressions 0″.125 in depth. These are the distances from the approximately elliptic arc that would have formed the apparent terminator if the irregularities had not existed. Thus we have the heights of the irregularities from a curve that did not exist given to three decimals of a second of arc! And there is nothing to show that the varying distances of the planet were taken into account, either. Every practical astronomer knows that the *first* decimal place is uncertain; the systematic errors in such cases can easily and generally do exceed a tenth of a second. To say that the results are accurate because they are the mean of a large number of observations is to say that if a stranger to Colorado's clear atmosphere should waken unexpectedly on Pike's Peak and guess the distances to several hundred neighboring peaks, the mean of all the guesses would be very near their average distance.

There is not much demand for mathematical analysis in a popular book on Mars, nor is the application of that little always happy. On pages 133–134, after stating that practically all the canals follow the arcs of great circles, and necessarily appear curved when viewed obliquely, the author writes, "apparent straightness throughout is only possible in comparatively short lines. For a very long arc [of a great circle] upon the surface of a revolving globe tilted toward the observer to appear straight in its entirety it must lie due north and south." This is incorrect. If the apparent center of the planet's disc is at 18° south latitude, which was the average for Mars in 1894, then every arc of every great circle that can be drawn in any direction through any point that lies on the minus 18° circle of latitude will appear straight twice every day. An infinite number of such circles can be drawn. Mr.

Lowell's misconception of the mathematical principles of the 'great circle' is fundamental. Does it render null and void his conclusion that the canals lie on arcs of great circles?

Mr. Lowell found that the surface markings on Mars came to the central meridian about twenty minutes later than the predicted time; a discrepancy, it should be said, to which Prof. Keeler called special attention in 1892.

To what extent Mr. Lowell's future observations will modify his map is uncertain. Drawings of Mars by different observers even on the same night and with the same telescope are proverbially different. So far as the drawings by the three Flagstaff observers have been published, the proverb still seems to be in force.

Mr. Lowell is entitled to great credit for devoting his private means so generously to establishing and conducting an observatory, and for his efforts in search of the best, but imperfect, atmospheric conditions. He is likewise fully aware of the necessity of making the observations continuously and systematically. Whatever advances Mr. Lowell may have made in Martian study, or may make in the future, will be fully accredited to him and warmly welcomed by all astronomers.

Mr. Lowell's book is written in a lively and entertaining style, and is printed and illustrated faultlessly. It is true that the theories advanced are mostly old ones, suggested by Schiaparelli, Pickering and others, many of them having been elaborated by Flammarion and others; but Mr. Lowell has presented them very fully and suggestively. Scientifically, the leading faults of the book are: First, that so elaborate an argument for intelligent life on the planet, embracing a complex system of seasonal changes, should be based upon observations covering only one-fourth of only one Martian year; and, secondly, that there should be so many evidences of apparent lack of familiarity with the literature of the subject.

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Text-book of the Embryology of Invertebrates. By Dr. E. Korschelt and Dr. K. Heider. Translated from the German by Edward L. Mark, Ph. D., and W. Mc. Woodworth, Ph. D., with additions by the authors and translators. Part I.: Porifera, Cnidaria, Ctenophora, Vermes, Enteropneusta, Echinodermata. New York: Macmillan & Co. 8vo. Pp. xv+484. 1895. $4.00.

The first Heft of the special part of Korschelt and Heider's well-known Lehrbuch, of which this is the English translation, appeared in 1890; the second Heft appeared in 1892 and the third in 1893. The three parts together form a volume of some fifteen hundred pages, illustrated by some nine hundred figures. They complete the special part of the work, that which presents the facts of embryology. A general part, to deal with theories and conclusions, is promised.

The first volume of Balfour's Comparative Embryology, dealing with invertebrates, appeared in 1890, and following that, the work of Korschelt and Heider was the first attempt at a 'broad and comprehensive' treatment of the whole field of invertebrate embryology. The book has been for several years in the hands of zoologists all over the world and is recognized as an excellent and indispensable reference book, the only one of its kind since Balfour. The labor involved in reading the special papers dealing with each group of animals treated and in sifting and arranging their results is so enormous, and the work of Korschelt and Heider has been so well done, that the book is likely for many years to remain without a rival. It is too well known to need critical treatment in this place.

The translation under consideration covers the first three hundred and twenty pages of the original. The remaining four-fifths of the book is to be rendered by another translator.

The German has been more freely rendered than in Mark's translation of Hertwig's Textbook of Embryology, and this gives the present book better literary form and makes it easier reading. At the same time the original has been so closely followed that nothing is lost or its meaning. The few instances where the English is not perfectly clear are not likely to confuse anyone who is prepared to read the book. Here are some of them: On p. 17 'differenten' is rendered by differentiated, which